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Technical Blog

Leveraging 80 ksi WWR as a Structural Reinforcement Substitution

Welded wire reinforcement (WWR) is commonly manufactured to achieve a yield strength of 80 ksi, in turn presenting itself as a savings-laden structural alternative to the 60 ksi mild steel reinforcement that continues to dominate the reinforced concrete construction landscape.

For appropriate applications, simple equivalency calculations can be carried out by WWR manufacturers' technical staffs to determine a lesser cross-sectional area of WWR that provides "equal strength" to that of an originally-specified 60 ksi reinforcement solution. The general equivalency equation is presented below.

$$\frac{\textbf{\textit{WWR wire size}} \times \textbf{\textit{WWR yield strength}}}{\mathbf{100} \times \textbf{\textit{wire spacing in inches}}} = \frac{\textbf{\textit{Rebar area}} \times \textbf{\textit{Rebar yield strength}}}{\textbf{\textit{Rebar spacing in inches}}}$$

The equivalency equation can be rearranged by the user depending on the attribute being calculated.

Examples below illustrate the simplicity of the conversion when used in the determination of alternatives for original designs utilizing 60 ksi reinforcing bar.

EXAMPLE 1

Known Attributes	
Rebar size	#5
Rebar area	0.310 in^2
Rebar spacing	10 inches on center
Rebar yield strength	60 ksi
Selected wire spacing	10 inches on center
WWR yield strength	80 ksi

Find the WWR wire size that provides equal strength.

$$WWR\ wire\ size = \frac{100 \times (Wire\ spacing) \times (Rebar\ area) \times (Rebar\ yield\ strength)}{(Rebar\ Spacing) \times (WWR\ yield\ strength)}$$

$$WWR\ wire\ size = \frac{100 \times (10) \times (0.31) \times (60)}{(10) \times (80)}$$

$$\textbf{\textit{WWR wire size}} = \mathbf{23.25} = \textbf{\textit{use D}}\mathbf{23.3\ @\ 10"}\ \textbf{\textit{oc}}$$

As an added check, one can confirm the simple equality:

$$(A_s f_y)_{wwr} = (A_s f_y)_{rebar}$$

$$\frac{0.233\ in^2}{10"} \times 12" \times 80\ ksi = 22.37\ kips \approx \frac{0.310\ in^2}{10"} \times 12" \times 60\ ksi = 22.32\ kips$$

EXAMPLE 2

Known Attributes	
Rebar size	#4
Rebar area	0.200 in^2
Rebar spacing	7 inches on center
Rebar yield strength	60 ksi
Selected wire spacing	4 inches on center
WWR yield strength	80 ksi

Find the WWR wire size that provides equal strength.

$$WWR\ wire\ size = \frac{100 \times (Wire\ spacing) \times (Rebar\ area) \times (Rebar\ yield\ strength)}{(Rebar\ Spacing) \times (WWR\ yield\ strength)}$$

$$WWR\ wire\ size = \frac{100 \times (4) \times (0.20) \times (60)}{(7) \times (80)}$$

$$\boldsymbol{WWR\ wire\ size = 8.57 = use\ D8.6\ @\ 4''\ oc}$$

As an added check, one can confirm the simple equality:

$$(A_s f_y)_{wwr} = (A_s f_y)_{rebar}$$

$$\frac{0.086\ in^2}{4''} \times 12'' \times 80\ ksi = 20.64\ kips \approx \frac{0.200\ in^2}{7''} \times 12'' \times 60\ ksi = 20.57\ kips$$

EXAMPLE 3

Known Attributes	
Rebar size	#4
Rebar area	0.200 in^2
Rebar spacing	16 inches on center
Rebar yield strength	60 ksi
Selected wire size	D15.0
WWR yield strength	80 ksi

Find the WWR wire spacing that provides equal strength.

$$WWR\ wire\ spacing = \frac{(WWR\ wire\ size) \times (WWR\ yield\ strength) \times (Rebar\ spacing)}{100 \times (Rebar\ area) \times (Rebar\ yield\ strength)}$$

$$WWR\ wire\ spacing = \frac{(15) \times (80) \times (16)}{100 \times (0.200) \times (60)}$$

$$\boldsymbol{WWR\ wire\ spacing = 16 = use\ D15.0\ @\ 16''\ oc}$$

As an added check, one can confirm the simple equality:

$$(A_s f_y)_{wwr} = (A_s f_y)_{rebar}$$

$$\frac{0.150\ in^2}{16''} \times 12'' \times 80\ ksi = 9\ kips \approx \frac{0.200\ in^2}{16''} \times 12'' \times 60\ ksi = 9\ kips$$

EXAMPLE 4

Known Attributes	
Rebar size	#5
Rebar area	0.310 in^2
Rebar spacing	10 inches on center
Rebar yield strength	60 ksi
Selected wire size	D20.0
WWR yield strength	80 ksi

Find the WWR wire spacing that provides equal strength.

$$WWR\ wire\ spacing = \frac{(WWR\ wire\ size) \times (WWR\ yield\ strength) \times (Rebar\ spacing)}{100 \times (Rebar\ area) \times (Rebar\ yield\ strength)}$$

$$WWR\ wire\ spacing = \frac{(20) \times (80) \times (10)}{100 \times (0.310) \times (60)}$$

$$\boldsymbol{WWR\ wire\ spacing = 8.6 = round\ down\ to\ 8.5", use\ D20.0\ @\ 8.5"\ oc}$$

As an added check, one can confirm the simple equality:

$$(A_s f_y)_{wwr} = (A_s f_y)_{rebar}$$

$$\frac{0.200\ in^2}{8.5"} \times 12" \times 80\ ksi = 22.6\ kips \approx \frac{0.310\ in^2}{10"} \times 12" \times 60\ ksi = 22.3\ kips$$

In pursuing an equal strength WWR conversion - and depending on the structural criticality of the application itself - it is important that the specifier be engaged in the process and ultimately accept the high strength substitution. In providing a lower cross-sectional area of reinforcing steel than what was used by the specifier in their original design, there can be an impact on the reinforced concrete element's serviceability response, as a reduction in steel area generally corresponds to an increase in the member's deflection/displacement. For slabs and beams, this manifests in downward deflection, while for walls – depending on slenderness and eccentricity of loading – an increase in flexural demand resulting from P-Δ effect can occur. While these increases are typically manageable, in many cases they are not negligible and deserve a specifier's cursory review, especially in the case of elevated structural components.

The inherent wire size and spacing versatility of WWR, combined with the readily-available 80 ksi option, can not only result in significant material savings on a project, but when properly coordinated and implemented it leverages the time and installation savings that have long been associated with WWR as a structural solution.

For more information on WWR, refer to www.wirereinforcementinstitute.org.